PATENT SPECIFICATION

DRAWINGS ATTACHED

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COMPLETE SPECIFICATION

Gear Change Mechanism

We, ROLLS-ROYCE LIMITED, a British company of Nightingale Road, Derby, Derbyshire, do hereby declare the invention, for which we pray that a patent may be granted to us and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention concerns a gear change mechanism.

Although the invention is not restricted, it is more particularly concerned with a gear change mechanism whose input shaft is driven by a turbine the exhaust gases from which pass through a heat exchanger. When the input shaft is so driven, it may be difficult to change gear. This is because, by reason of the gas flow through the heat exchanger, and the inertia of the rotating parts of the turbine, it may take the engine some time to respond to changes in throttle setting.

According therefore to the present invention there is provided a gear change mechanism comprising an input shaft, an output shaft, first and second transmissions which are adapted to transmit drive from the input shaft to the output shaft in a relatively high and in a relatively low gear ratio respectively, each said transmission incorporating a drive transmitting clutch which is engaged and disengaged when the drive-transmitting clutch in the other transmission is respectively disengaged and engaged, a third transmission which drivingly interconnects the input and output shafts, the third transmission incorporating a normally disengaged slipping clutch whose output side is arranged to be rotated more slowly than its input side, and means for effecting temporary engagement of the slipping clutch, such temporary engagement being associated with engagement of a selected drive-transmissing clutch and disengagement of the other drive-transmitting clutch.

As will be appreciated, in the case of the gear change mechanism of the present invention, the change to a higher or a lower gear may be effected under power with no alteration to the throttle setting.

Speed responsive means are preferably provided for effecting temporary engagement of the slipping clutch when the speed of the output shaft has reached a predetermined value.

The slipping clutch may be constituted by a fluid coupling, the means for effecting temporary engagement of the slipping clutch being arranged to provide a temporary supply of hydrauiic fluid to the fluid coupling. Thus, there may be provided a hydraulic fluid reservoir, a conduit for conveying the hydraulic fluid from the reservoir to the fluid coupling, a pump for pumping the hydraulic fluid through the conduit, said pump being driven, directly or indirectly, from the output shaft, a vent passage for allowing hydraulic fluid to pass from the fluid coupling back to the reservoir, and valve means for controlling the respective fluid flows through the conduit and vent passage.

Preferably, the drive-transmitting clutch in the said first transmission is a synchronous clutch which is fully engaged only when the parts thereof are rotating synchronously, the drive-transmitting clutch in the said second transmission being either a said synchronous clutch or a unidirectional clutch which is adapted to transmit drive in a predetermined sense from the input shaft towards the output shaft only.

At least one further transmission may be provided which is adapted to transmit drive from the input shaft to the output shaft and which incorporates a said synchronous clutch.

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Means may be provided for locking the or each synchronous clutch in the engaged position.

The or each synchronous clutch preferably comprises concentrically arranged input and output portions with a rotary member therebetween which is helically splined onto one of the portions, the rotary member having a set of dogs and a set of pawls which are axially spaced from and aligned with said dogs which may mesh with dogs on the other portion.

The rotary member may preferably be moved to an inoperative position in which the pawls and dogs on the rotary member are maintained out of contact with the dogs on the said other portion. Thus the said valve means may control movement of the rotary member into and out of the said inoperative position.

The invention is illustrated, merely by way of example, in the accompanying drawings, in which:—

Figure 1 is a diagrammatic representation of a rail vehicle provided with a gear change mechanism according to the present invention, and

Figure 2 is a sectional view of a synchronous clutch forming part of the gear change mechanism of Figure 1.

Terms such as "left" and "right" as used in the description below, are to be understood to refer to directions as seen in the drawings.

Referring to the drawings, a rail vehicle is provided with a gas turbine engine 10 which comprises in flow series a centrifugal compressor 11, a heat exchanger 12, combustion equipment 13, and turbines 14, 15 the turbine exhaust gases being exhausted to atmosphere via the heat exchanger 12.

The turbine 14 is mounted on a shaft 16 which drives the compressor 11. The turbine 15, however, is a free turbine which is mounted on a shaft 20 provided with a relatively small gear 21 which meshes with a relatively large gear 22. The gear 22 is mounted on a shaft 23 which carries a relatively small gear 24 meshing with a relatively large gear 25 on an input shaft 26 of a gearbox 30. Thus the gears 21, 22, 24, 25 constitute reduction gearing between the free turbine 15 and the input shaft 26.

A gear 31 is mounted on the input shaft 26, the gear 31 meshing on diametrically opposite sides thereof with similarly sized gears 32, 33, respectively.

The input shaft 26 is adapted to drive a concentrically arranged output shaft 34 by way of a synchronous clutch 35 (see Fig. 2).

The clutch 35 incorporates a rotary sleeve 36 which has internal helical splines 37 which engage external helical splines 38 on the input shaft 26. The rotary sleeve 36 also has a set of pawls 41 which are axially spaced from and aligned with a set of dogs 42 thereon.

The output shaft 34 has two aligned, axially spaced sets of dogs 43, 44, the pawls 41 being adapted to cooperate with the dogs 43, and the dogs 42 being adapted to cooperate with the dogs 44.

A locking sleeve 45 is axially splined onto the rotary sleeve 36 and is provided with dogs 46 which are adapted to mesh with dogs 47 on a flange 50 of the input shaft 26. The locking sleeve 45 has shoulders 51 52 which are respectively adapted to abut shoulders 53, 54 on the rotary sleeve 36.

The rotary sleeve 36 may be maintained in an inoperative position, shown in Fig. 2, in which the pawls 41 and dogs 42 are maintained out of contact with the dogs 43, 44. In this position, no drive may be transmitted from the input shaft 26 to the output shaft 34.

The locking sleeve 45 may, however, be moved towards the right so as first to bring the shoulders 52, 54 into abutment and thereafter to move the rotary sleeve 36 towards the right and so into a mid-position (not shown) in which the pawls 41 engage the dogs 43. If the speed of the output shaft 34 is at this time less than that of the input shafting 26, the rotary sleeve 36 will (by reason of the helical splines 37, 38) move towards the right and into an operative position (not shown) in which a shoulder 55 on the rotary sleeve 36 engages the flange 50. By the time this occurs, the speeds of the input shaft 26 and output shaft 34 will be the same, and the dogs 42, 43 will be in mesh, whereby torque may be transmitted from the input shaft 26 to the output shaft 34.

The locking sleeve 54 may be moved towards the right and into a locked position (not shown) in which the dogs 46, 47 are in engagement. In this locked position, the shoulder 52 prevents the rotary sleeve 36 being moved towards the left so as to effect disengagement of the dogs 42, 44.

Unless, however, the locking sleeve 45 is in the locked position, torque cannot be transmitted from the output shaft 34 to the input shaft 26 because, if there is any tendency for this to occur, the rotary sleeve 36 will move towards the left so as to bring the dogs 42, 44 out of engagement, whilst any subsequent engagement between the pawls 41 and the dogs 43 would merely cause ratcheting of the pawls.

Accordingly, when the clutch 35 is fully engaged, i.e. when the rotary sleeve 36 is in the said operative position, there is thus a direct drive from the input shaft 26 to the output shaft 34, whereby to provide an intermediate gear.

The gear 32 is mounted on a layshaft 60 on which is rotatably mounted a gear 61. The gear 61 is adapted to be driven by the layshaft 60 via a uni-directional clutch or free wheel 62, the gear 61 being a relatively small gear which meshes with a relatively large gear 63 mounted on the output shaft 34.

The unidirectional clutch 62 is adapted to

transmit drive in a predetermined sense only from the input shaft 26 towards the output shaft 34 and not in the reverse direction. When the unidirectional clutch 62 is engaged, there is a low gear drive from the input shaft 26 to the output shaft 34.

A gear 64 is also rotatably mounted on the layshaft 60 and is adapted to be driven therefrom via a synchronous clutch 65. The synchronous clutch 65, which comprises a locking sleeve 66, has a construction closely similar to that of the synchronous clutch 35.

The gear 64 is a relatively large gear which meshes with a relatively small gear 70 on the output shaft 34. Accordingly, when the synchronous clutch 65 is engaged, a high gear drive is effected from the input shaft 26 to the output shaft 34.

The gear 33 is mounted on a layshaft 71 which carries the input side of a fluid coupling 72. The output side of the fluid coupling 72 is mounted on a layshaft 73 on which is mounted a relatively large gear 74 which is driven from the output shaft 34 by way of a relatively small gear 75 mounted thereon.

A bevel gear 76 is mounted on the layshaft 73 and meshes with a bevel gear 77 which drives an impeller 80 of a centrifugal pump 81. The pump 81 is adapted to pump hydraulic fluid from a reservoir 82 through conduits 83, 84, 85 to fill the fluid coupling 72 so as to render the latter operative.

A valve assembly 86 is settable in a first position in which it permits communication between the conduits 84, 85 and in a second position in which it permits communication between the conduit 85 and a vent passage 87. Accordingly, when the valve assembly 86 is placed in the first position, fluid will be supplied by the pump 81 to the fluid coupling 72, while when the valve assembly 86 is placed in the second position, fluid will be withdrawn from the fluid coupling 72.

A speed responsive means (not shown), which is responsive to the speed of the output shaft 34, or to some speed related thereto (e.g. that of the rail vehicle) is arranged by means not shown to place the valve assembly 86 in the said first position whenever the said speed attains one of two values respectively corresponding to those at which it is desirable to change up to the said intermediate or to the said high gear (or down to the said intermediate and low gears).

The locking sleeve 66 is connected by a lever 90 to a piston 91 which is movable into three positions by a supply of hydraulic fluid controlled by the valve assembly 86. The locking sleeve 66 may thus be moved into the operative, inoperative and mid positions.

Similarly, the locking sleeve 45 of the synchronous clutch 35 is connected by a lever 93 to a piston 94 which is movable into three positions by a supply of hydraulic fluid controlled by the valve assembly 86.

The output shaft 34 is connected by way of a universal joint 95 to a shaft 96, the latter being connected by a universal joint 97 to a shaft 100.

The shaft 100 extends into a gear box 101 where it is provided with a bevel gear 102. The bevel gear 192 meshes with bevel gears 103, 104 respectively. An axially movable connector member 105 is splined onto a shaft 106 and has two sets of dog teeth 110, 111, which on axial movement of the connector member 105, are adapted to engage dog teeth 112, 113 respectively on the bevel gears 103, 104. Thus, the direction of rotation of the shaft 106 depends on the axial position of the connector member 105.

The shaft 106 has mounted therein a relatively small gear 114 which meshes with a relatively large gear 115 on an axle 116 carrying wheels 117 of the rail vehicle.

In operation, when the gas turbine engine 10 has been started and the said rail vehicle is stationary, the input shaft 26 and the lay shafts 60, 71 will rotate. There will however be no drive through the synchronous clutches 65, 35, since the output shaft 34 will be stationary at this time, and the input and output sides of these synchronous clutches will not therefore be rotating at the same speed. A drive will, however, be available, through the uni-directional clutch 62 and gears 61, 63, whereby to provide a low gear.

When the speed of the rail vehicle has reached a value at which intermediate gear should be selected, the said speed responsive means will cause the valve assembly 86 to be moved to its said first position, with the result that the fluid coupling 72 will be filled with hydraulic fluid which has been pumped from the reservoir 82 by the pump 81. As will be seen from the drawings, however, the gears 74, 75 are such that the output side of the fluid coupling 72 always rotates at a lower speed than the input side thereof. Accordingly, when the fluid coupling 72 is filled with hydrauic fluid, the tendency will be for the output side of the fluid coupling 72 to increase in speed and for the input side thereof to have its speed correspondingly decreased. However, since the output side of the fluid coupling 72 is connected to the wheels 117, and has a greater inertia to overcome than the input side, the input side will slow down faster than the output side can accelerate. As a result, the unidirectional clutch 62 will over-run. Moreover, when the speed of the input shaft 26 is less than that of the output shaft 34, the locking sleeve 45 (and hence the rotary sleeve 36) is moved by the piston 94 into the said mid-position in which the pawls 41 engage the dogs 43. The fluid coupling 72 is then emptied with the result that the speed of the input shaft 26 increases until it becomes the same as that of the output shaft 34 and when this occurs the rotary sleeve 36 will move to the

right to bring the dogs 42, 44 into engagement. The synchronous clutch 35 will thus be fully engaged and intermediate gear will have been selected.

Similarly, when the speed of the rail vehicle has reached a value at which high gear should be selected, the said speed responsive means moves the valve assembly 86 into the said first position, as a result of which the fluid coupling 72 becomes filled with hydraulic fluid. This causes the speed of the input shaft 26 to decrease relatively to that of the output shaft 34. In consequence, the rotary sleeve 36 is moved to the said mid-position, since the input and output sides of the clutch 35 will no longer be moving synchronously, whilst it will subsequently be moved by the piston 94 to the inoperative position. The valve assembly 86 will then be moved to the said second position and the fluid coupling 72 will be emptied of its hydraulic fluid. The shaft 60 will then increase in speed until its speed is that of the gear 64, and when this occurs the synchronous clutch 65 will be fully engaged.

The operation for changing down under power, i.e. when the rail vehicle is climbing up a gradient, will be the same as for changing up to a higher gear under power. When it is necessary to change from the high gear to the intermediate gear under power, the fluid coupling 72 will be filled by the operation of the valve assembly 86, and this will slow the rotation of the shafts 71, 26 and 60 relative to the output shaft 34. This will cause the clutch 65 to disengage, while the rotary sleeve 36 will be moved to engage the pawls 41 with the dogs 43. Thus when the fluid coupling 72 is emptied, the input shaft 26 will increase in speed until it reaches synchronising speed with the output shaft 34, at which time the pawls 41 will cause the clutch 35 to become fully engaged. Inermediate gear drive to the output shaft 34 will therefore be effected.

Changing down into low gear will be effected in a similar manner.

When the said rail vehicle is braken by application of the wheel brakes, the engine 10 will have been shut down and the input shaft 26 will be running more slowly in relation to the output shaft 34 than it does in any gear. Under these conditions all the clutches 35, 62, 65 will be disengaged and selection of a lower gear can be readily made without having to operate the fluid coupling 72.

When the rail vehicle is being driven in either intermediate or top gear, braking can be effected by moving the locking sleeve 45, 46 into the locked position and filling the fluid coupling 72 with hydraulic fluid. The input and output sides of the fluid coupling 72 will then be mechanically forced over each other with substantial resistance to rotation provided by the hydraulic fluid therein.

As will be appreciated, the fluid coupling 72 forms, in effect, a slipping clutch. Slipping clutches other than fluid couplings may, moreover, be employed if so desired.

It will also be appreciated that the gear change mechanism described above is also suitable for road vehicles powered by one or more gas turbine engines.

WHAT WE CLAIM IS:—

1. A gear change mechanism comprising an input shaft, an output shaft, first and second transmissions which are adapted to transmit drive from the input shaft to the output shaft in a relatively high and in a relatively low gear ratio respectively, each said transmission incorporating a drive-transmitting clutch which is engaged and disengaged when the drive-transmitting clutch in the other transmission is respectively disengaged and engaged, a third transmission which drivingly interconnects the input and output shafts, the third transmission incorporating a normally disengaged slipping clutch whose output side is arranged to be rotated more slowly than its input side, and means for effecting temporary engagement of the slipping clutch, such temporary engagement being associated with engagement of a selected drive-transmitting clutch and disengagement of the other drive-transmitting clutch.

2. Gear change mechanism as claimed in claim 1 comprising speed responsive means for effecting temporary engagement of the slipping clutch when a speed of the output shaft has reached a predetermined value.

3. Gear change mechanism as claimed in claim 2 in which the slipping clutch is constituted by a fluid coupling, the means for effecting temporary engagement of the slipping clutch being arranged to provide a temporary supply of hydraulic fluid to the fluid coupling.

4. Gear change mechanism as claimed in claim 3 comprising a hydraulic fluid reservoir, a conduit for conveying the hydraulic fluid from the reservoir to the fluid coupling, a pump for pumping the hydraulic fluid through the conduit, said pump being driven directly or indirectly, from the output shaft, a vent passage for allowing hydraulic fluid to pass from the fluid coupling back to the reservoir, and valve means for controlling the respective fluid flows through the conduit and vent passage.

5. Gear change mechanism as claimed in any preceding claim in which the drive-transmitting clutch in the said first transmission is a synchronous clutch which is fully engaged only when the parts thereof are rotating synchronously, the drive-transmitting clutch in the said second transmission being either a said synchronous clutch or a unidirectional clutch which is adapted to transmit drive in a pre-

determined sense from the input shaft towards the output shaft only.

6. Gear change mechanism as claimed in claim 5 in which there is at least one further transmission which is adapted to transmit drive from the input shaft to the output shaft and which incorporates a said synchronous clutch.

7. Gear change mechanism as claimed in claim 5 or 6 in which means are provided for locking the or each synchronous clutch in the engaged position.

8. Gear change mechanism as claimed in any of claims 5—7 in which the or each synchronous clutch comprises concentrically arranged input and output portions with a rotary member therebetween which is helically splined onto one of the portions, the rotary member having a set of dogs and a set of pawls which are axially spaced from and aligned with said dogs and which may mesh with dogs on the other portion.

9. Gear change mechanism as claimed in claim 8 in which the rotary member may be moved to an inoperative position in which the pawls and dogs on the rotary member are maintained out of contact with the dogs on the said other portion.

10. Gear change mechanism as claimed in claims 4 and 9 in which the said valve means controls movement of the rotary member into and out of the said inoperative position.

11. Gear change mechanism as claimed in any preceding claim in which the input shaft is driven by a turbine the exhaust gases from which pass through a heat exchanger.

12. Gear change mechanism substantially as described with reference to and as shown in the accompanying drawing.

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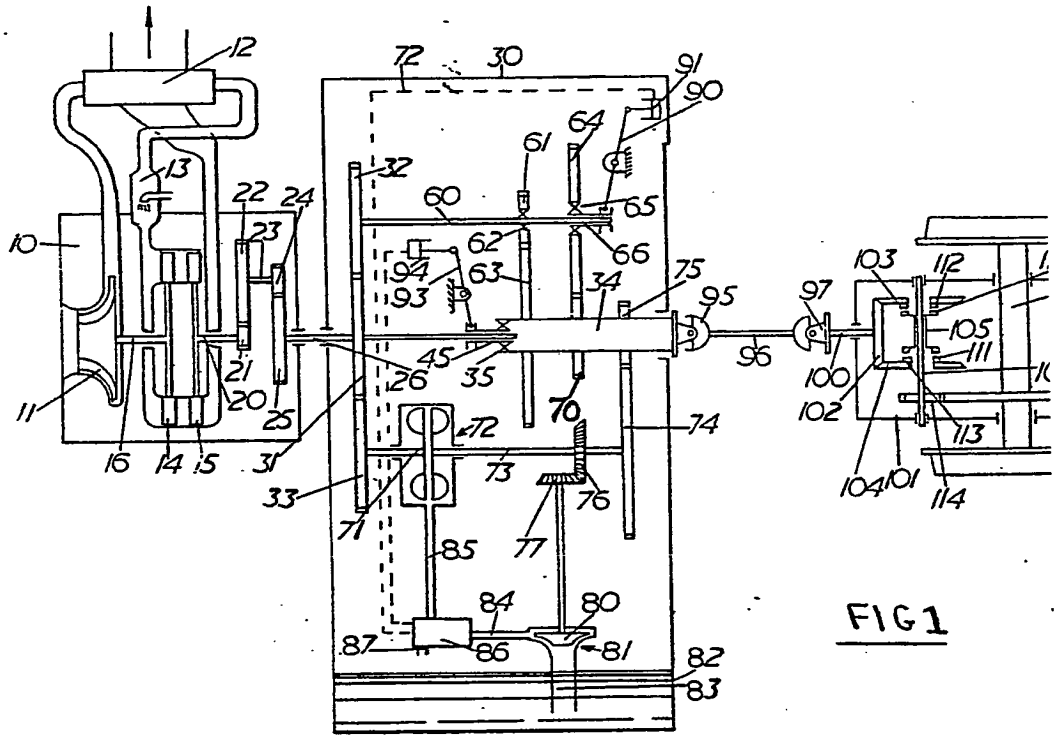

FIG1

1035386 COMPLETE SPECIFICATION

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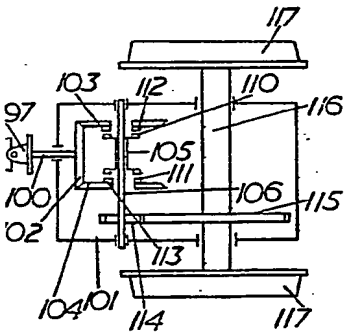
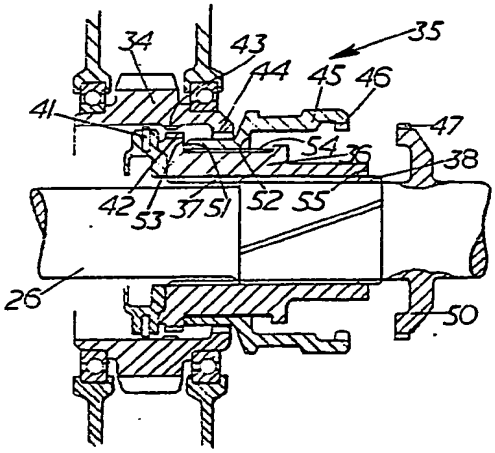


FIG1

FIG2



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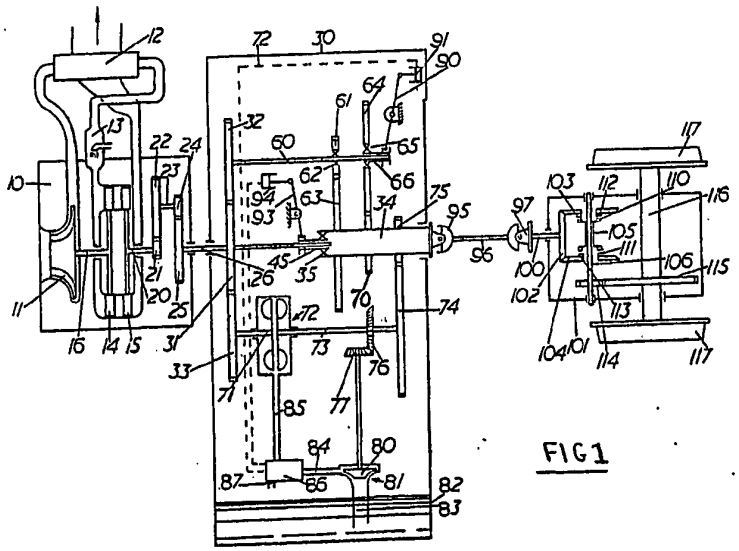

FIG1

FIG2